

Chapter-2

ECOLOGY AND ECOSYSTEM

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ECOLOGY

- ◎ The word ecology is derived from two greek words “oikos” meaning house, habitation or place of living and “logos” meanings ‘study’.
- ◎ Ecology is the study of interrelationship between living organisms and their physical and biological environment.
- ◎ Physical environment includes light and heat or solar radiation, moisture, wind, oxygen, carbon dioxide, nutrients is in soil, water and atmosphere.
- ◎ The biological environment includes organisms of all kind as well as plants and animals.

OBJECTIVE OF ECOLOGY

- ◎ The interrelationship between organisms in population and diverse communities.
- ◎ The temporal (sequential) changes (seasonal, annual, successional etc)
- ◎ The behavior under natural condition
- ◎ The structural adaptations and functional adjustments of organisms to their physical environment.
- ◎ The development in the course of evolution.
- ◎ The biological productivity and energy flow in natural system
- ◎ The development of mathematical models relate interaction of parameters and to predict the effects.

The main objective:

- ◎ Uncontrolled interference with natural population
- ◎ Unchecked felling of trees
- ◎ Environmental pollution

SCOPE OF ECOLOGY

- ◎ Ecology helps to tackle problems of pollution:
 1. Air, water, land erosion
 2. Floods
 3. Climate variation in seasonal patterns
 4. Green house effects
 5. Ozone layer depletion
 6. Ice melting of poles
 7. Acid rains
 8. Deforestation
 9. Provide people knowledge of environment protection
- ◎ Maintain ecological balance
- ◎ Understanding different cycles like N_2 , C, P, O_2 , H_2O
- ◎ Helps protecting flora and fauna
- ◎ Helps in finding productivity of the area
- ◎ Proper and deep study maintain balance in nature and prevent ecological disaster

CONT...

◎ Ecology plays important role in:

1. Human welfare
2. Agriculture
3. Management of grass lands
4. Forestry
5. Biological survey
6. Pest control and in conservation of wild life

◎ The international problem of environment pollution also needs ecological assistance

CLASSIFICATION OF ECOLOGY

1. **Autecology:** It deals with study of individual organism or an individual species. In other words it is the study of inter relationship between individual species or its population and environment.

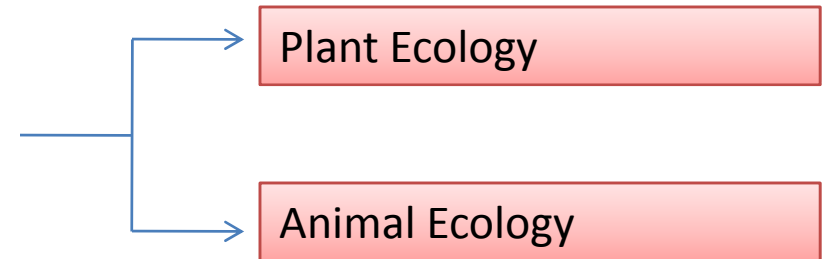
E.g. tree in the forest

2. **Synecology:** It deals with study of group of organism or species which are associate together as a unit. It is concerned with structure, nature, development and causes of distribution of communities

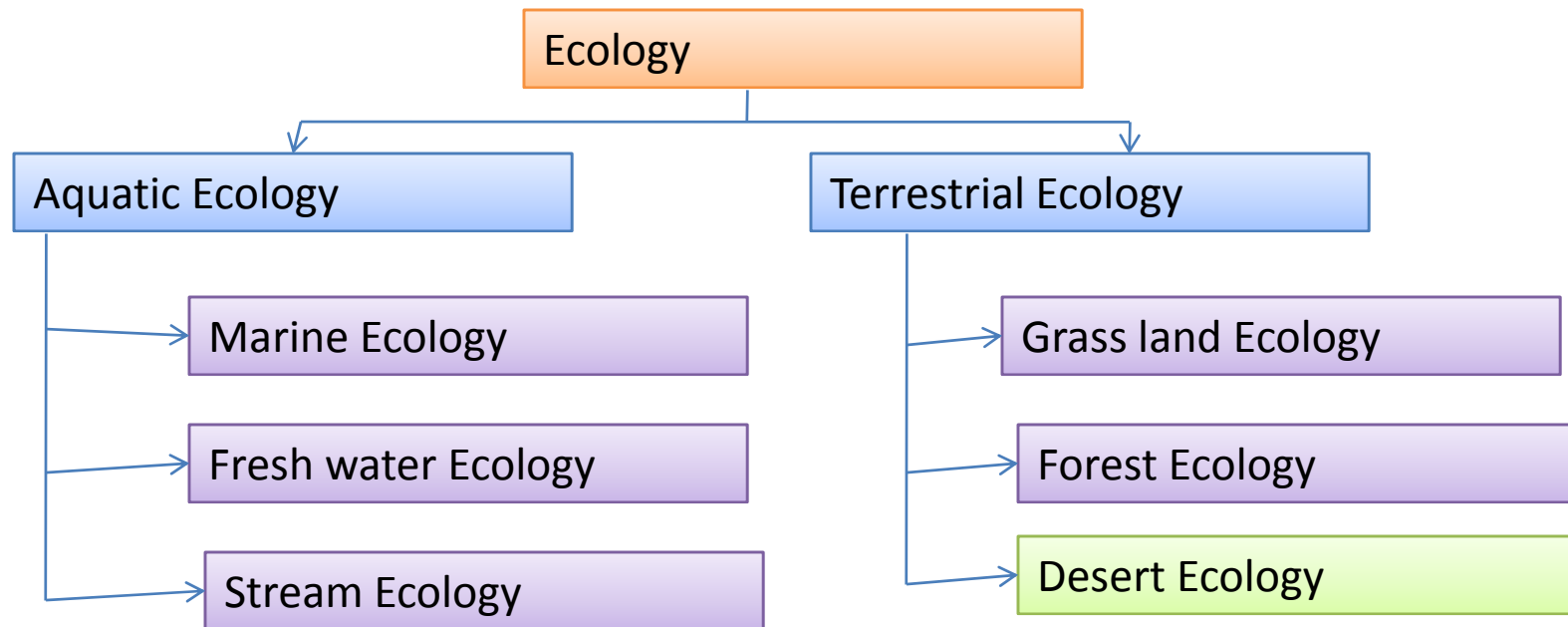
E.g. Forest

SUBDIVISION OF ECOLOGY

- Based on Taxonomic:

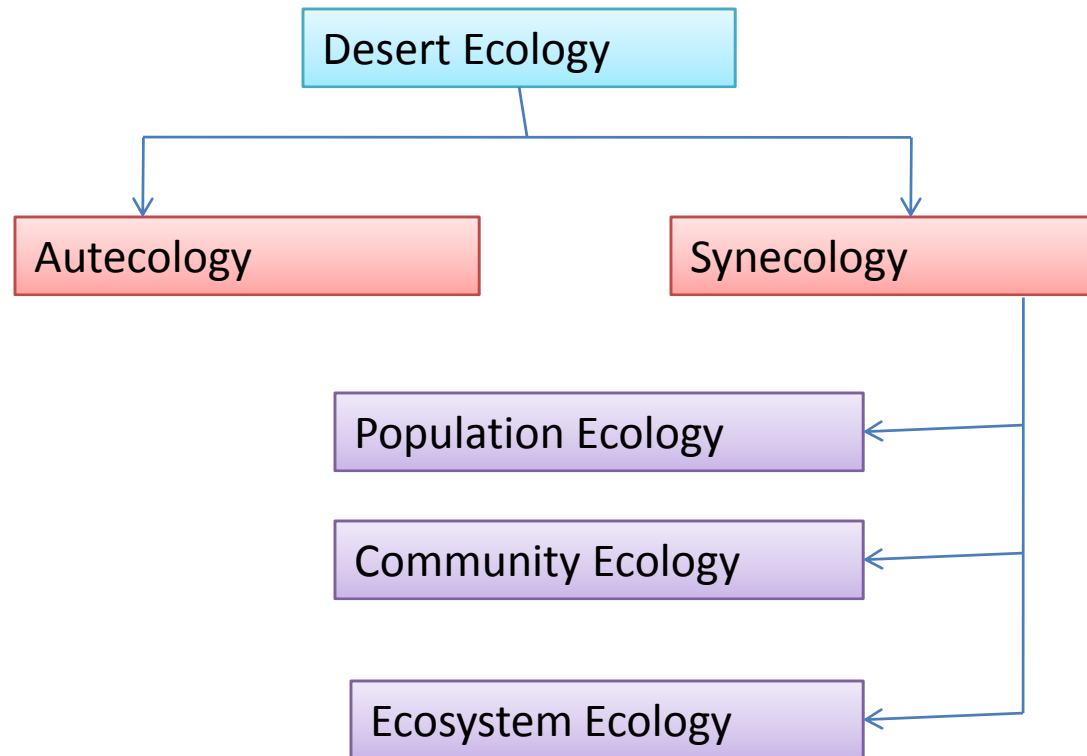


- Based on Habitats:



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- Based on level of organization:



BRANCHES OF ECOLOGY

- Productive Ecology
- Population Ecology
- Community Ecology
- Ecosystem Ecology
- Microbial Ecology
- Radiation Ecology
- Pollution Ecology
- Space Ecology

ECOSYSTEM

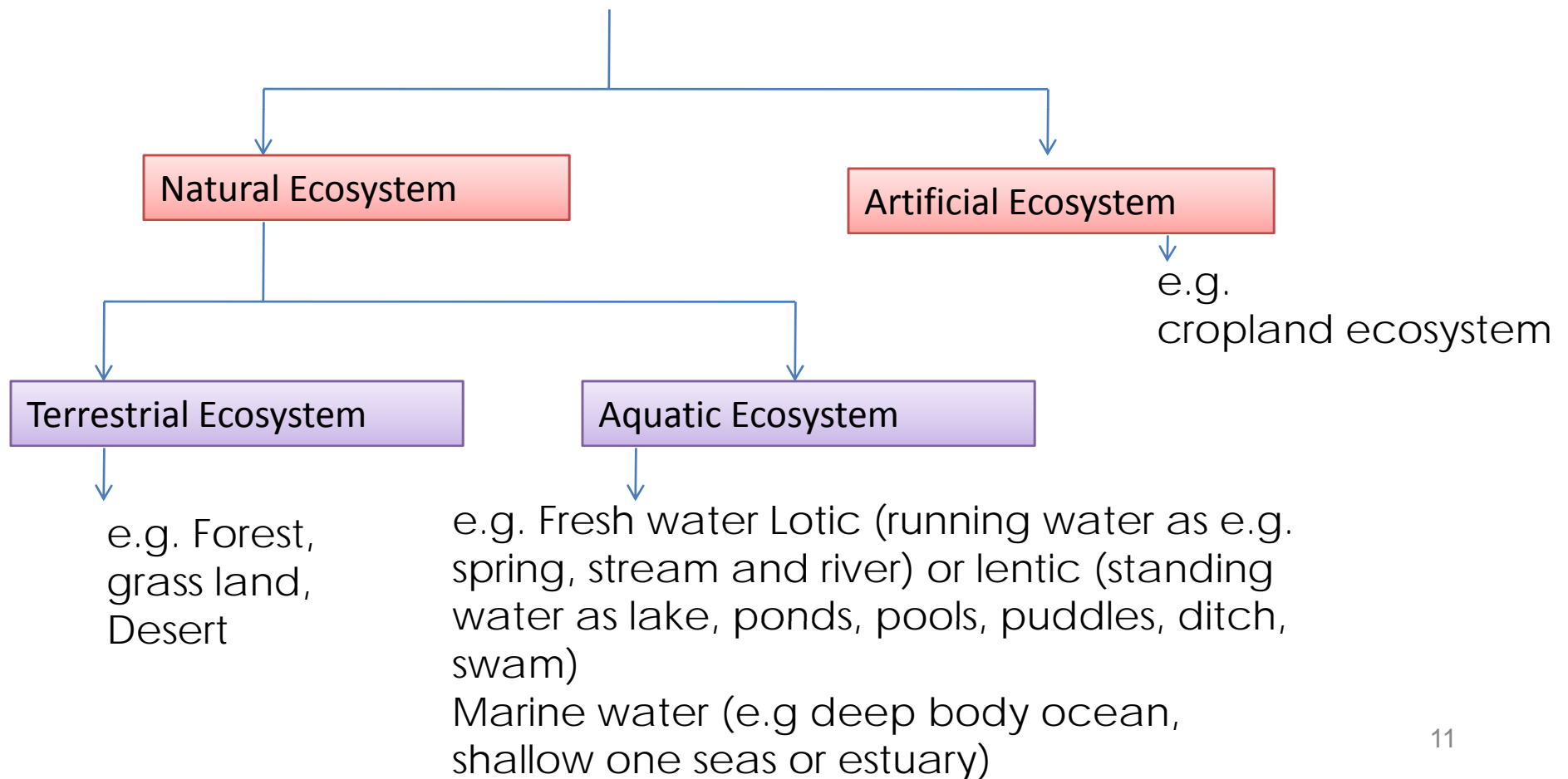
- ◎ Ecosystem is made up of two words “eco” and “system”. Eco means environment and system means an interacting and interdependent complex.

Definition of Ecosystem

1. The organisms of any community besides interacting among themselves, always have functional relationship with the environment. The structural and functional system of communities and environment is called ecological system.
2. It is a community of interdependent organisms together with the environment.
3. Any unit that includes all of the organisms in a given area interacting with the physical environment, so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles within the system.

TYPES OF EOSYSTEM OR KONDS OF ECOSYSTEM

- Types of Ecosystem



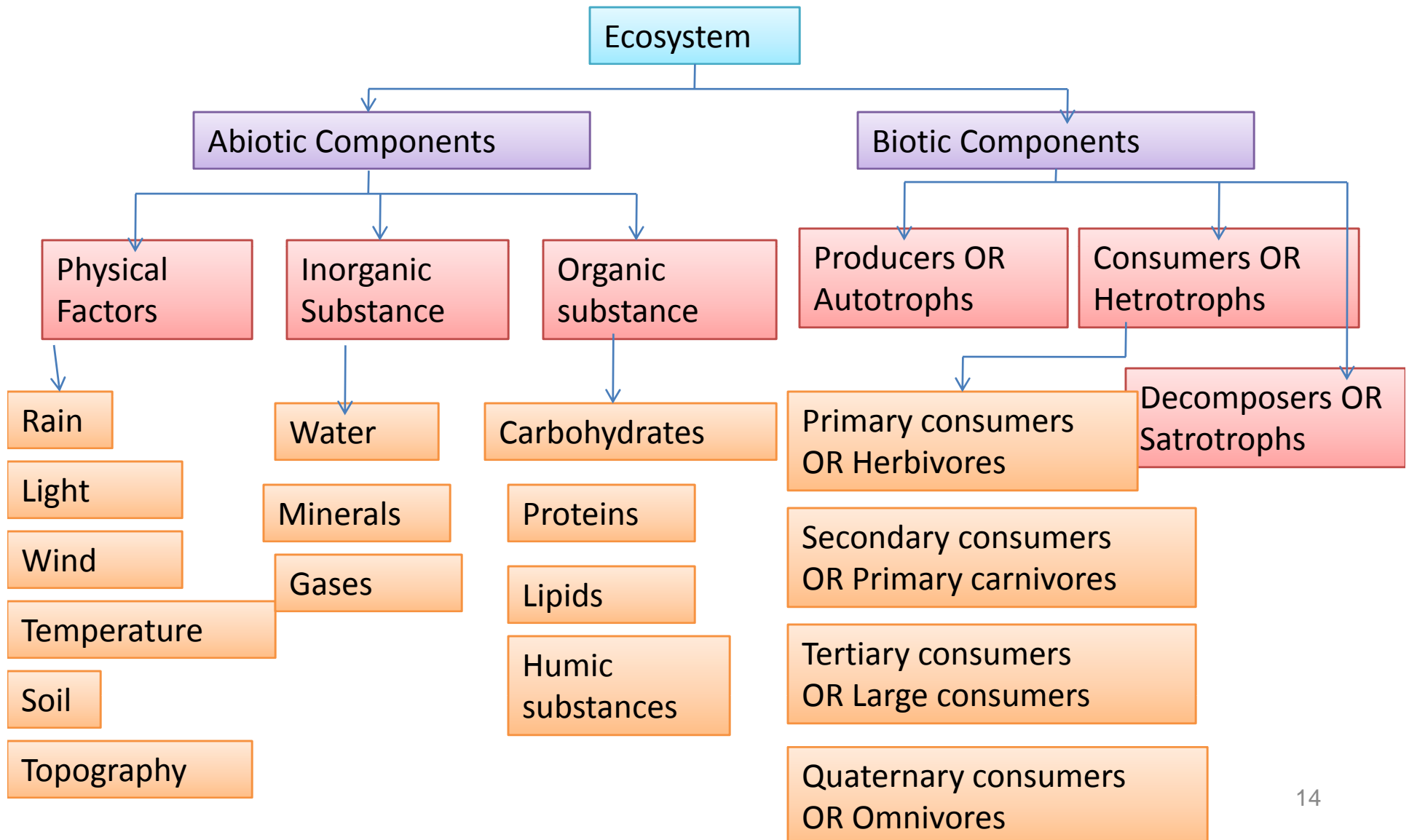
IMPORTANCE OF STUDYING ECOSYSTEM

- Provides information about the amount of solar energy in an area
- Provides data about the availability of mineral elements their utilization and recycling
- Provides information about relation between organisms as well as between organism and abiotic environment
- Provides information of productivity and number of producers and consumers
- The knowledge about pollution, natural resources and the conservation also can be gathered

CHARACTERISTICS OF AN ECOSYSTEM

- Major **structural and functional unit** of Ecology
- **Structure** is related to species diversity
- **Functional** is related to energy flow and material cycling through and within the system
- The relative amount of energy is needed to maintain an ecosystem depend on its structure
- The more complex structure, the lesser the energy it needs to maintain itself
- It matures by passing from lesser complex to more complex states.
- Early stages of each succession have an excess of potential energy and relatively high energy flow per unit biomass.
- Later stages have less energy accumulation and its flow through more diverse components
- Both environment and the energy fixation in any given ecosystem are limited and cannot be exceeded without causing serious undesirable effects

STRUCTURE OF ECOSYSTEM



ECOLOGICAL BALANCE

- In the natural environment there exists a perfect balance or equilibrium between the various organisms, this balance is called as ecological balance
- **Definition:** “A state of dynamic equilibrium within a community of organisms in which genetic, species and eco-system diversity remains stable, subject to stable, subject to gradual changes through natural succession”

ECOLOGICAL BALANCE

- ◎ The ecological balance may however get disturbed due to introduction of new species, sudden death of some species, natural hazard or man-made causes like deforestation, pollution etc.
- ◎ If the numerical ratio balance between different organisms is disturbed, then naturally, there will be shortage of food for certain species which may ultimately lead to large scale mortality of that species.
- ◎ A new equilibrium is finally reestablished in the changed condition
- ◎ In an ecosystem if there is large number of species of a particular type, there will be shortage of food for that species and after some time due to shortage of food death rate of that particular species will increase.
- ◎ This will also affect the species which feeds on that particular species, this in turn would affect the species of next trophic level and so on, as in an ecosystem every species are interconnected. So ultimately the whole ecosystem gets disturbed or becomes unstable.

ENERGY FLOW IN AN ECOSYSTEM

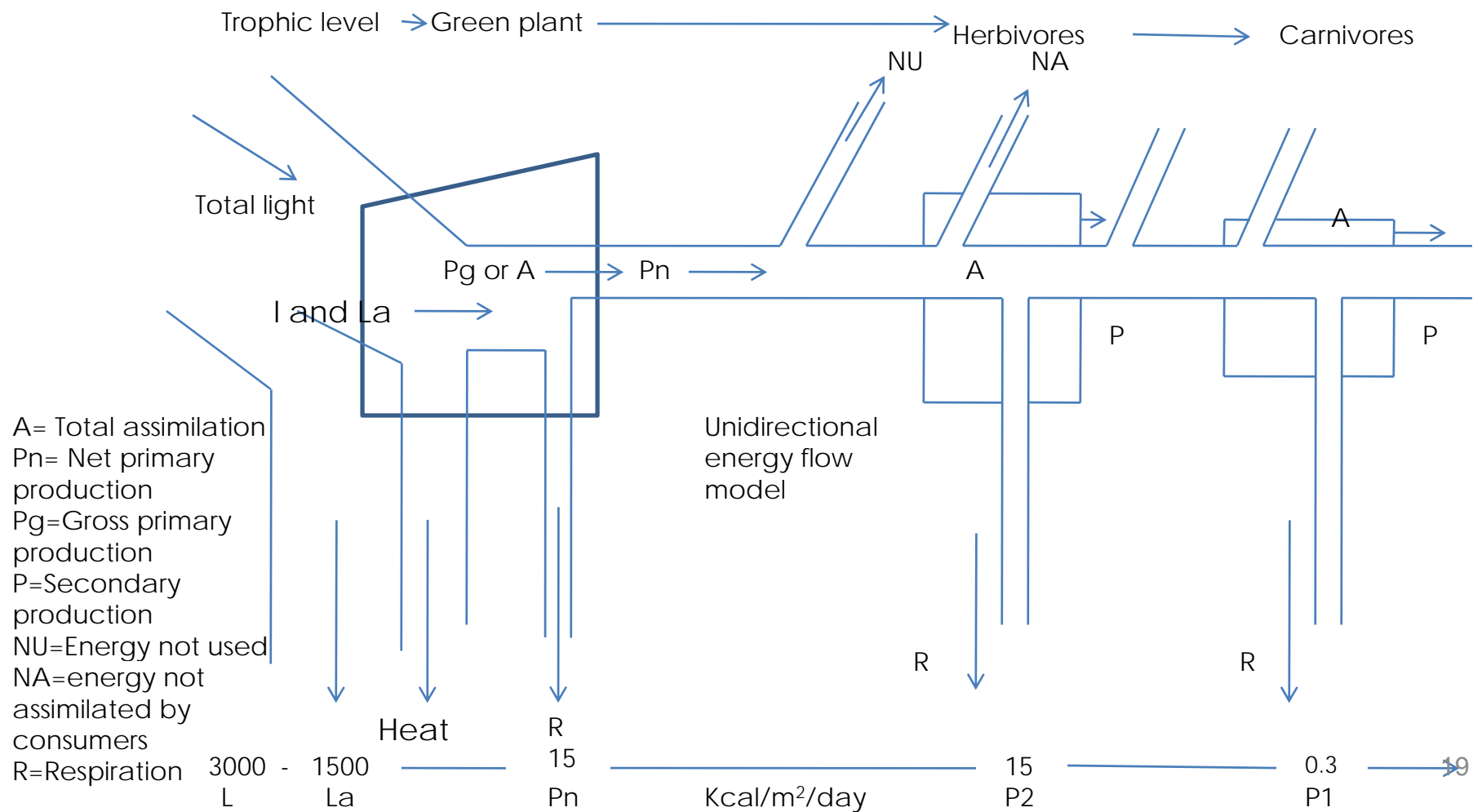
- To maintain life energy is required
- Energy enter from solar radiations
- Earth atmosphere present solar energy : $15 \times 10^8 \text{ cal/m}^2/\text{year}$
- Out of which, 47% of energy reaches earth surface and only 1-5 % of energy reaching the ground is converted into chemical energy by green plants.
- The plant make food by own by using raw material(water, salts, CO₂, sunlight) through photosynthetic organisms and passes on from one organism to another in the for of food.
- The flow of energy is unidirectional and non cyclic
- Energy enter ecosystem in form of solar convert into chemical energy by chemical energy by producers, from them energy passes to the lower trophic level to higher one.

ENERGY FLOW IN AN ECOSYSTEM

- ◎ This is the way energy is governed by laws of thermodynamics which state that:
 1. Energy is neither created nor destroyed but may be transferred from one from to another.
 2. During energy transfer there is degradation of energy from a concentrated form (mechanical, chemical or electrical etc) to dispersed form(heat).
- ◎ No energy transformation is 100% efficient.
- ◎ It is always accompanied by some dispersion or loss of energy in form of heat.

MODEL FOR ENERGY FLOW IN ECOSYSTEM

- Single channel energy flow model



Y SHAPED OR DOUBLE CHANNEL ENERGY FLOW MODEL

- ⊙ Common boundary for light, heat, import, export and storage of organic matter
- ⊙ Decomposers are placed in separate box to partially separate the grazing and detritus food chain.
- ⊙ Y-shaped energy flow is more realistic and practical than the single channel energy flow model because:
 1. It conforms to the basic stratified structure of ecosystem
 2. It separates the two chains i.e. grazing and detritus food chain in both time and space
 3. Micro consumers(bacteria and fungi) and the macro consumers (animals) differ greatly in size-metabolism relation in two models

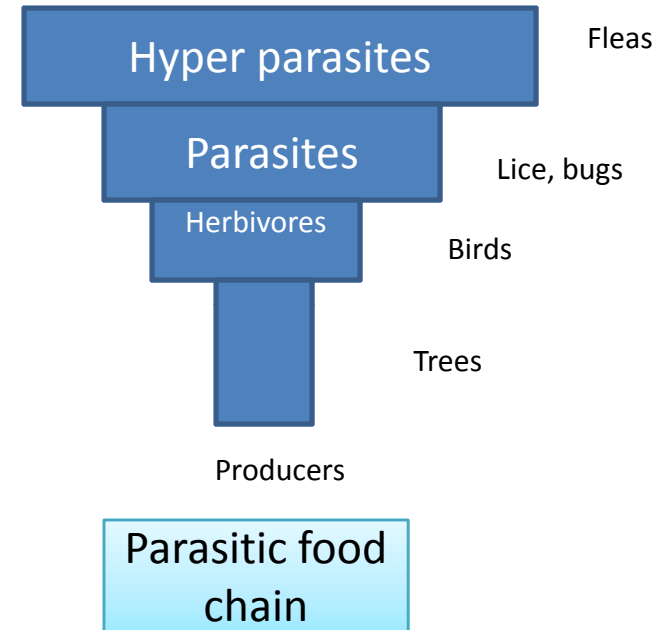
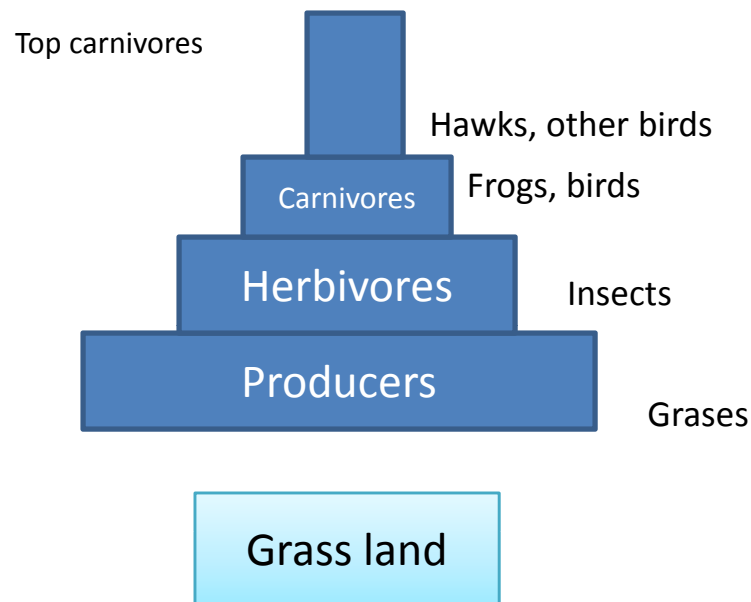
UNIVERSAL ENERGY FLOW MODEL

- As the energy takes place, there is gradual loss of energy at each level as indicated by narrower pipes and smaller boxes
- The loss of energy which is not utilized is NU.
- The energy lost in respiration which is for maintenance. The remaining energy is used for production.

ECOLOGICAL PYRAMIDS

- Graphical representation of trophic structure and function of ecosystem, starting with producers at the base and successive trophic levels forming the apex is known as ecological pyramid.
- Types
 1. Pyramids of numbers
 2. Pyramids of Biomass
 3. Pyramids of energy

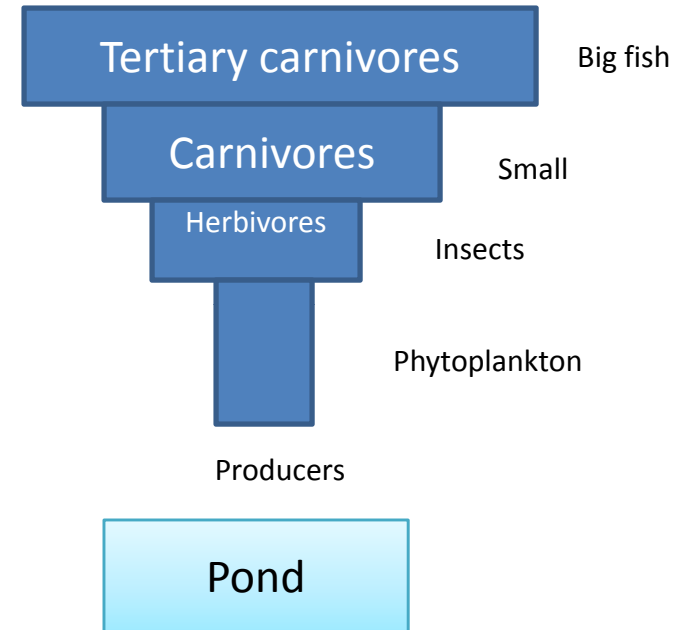
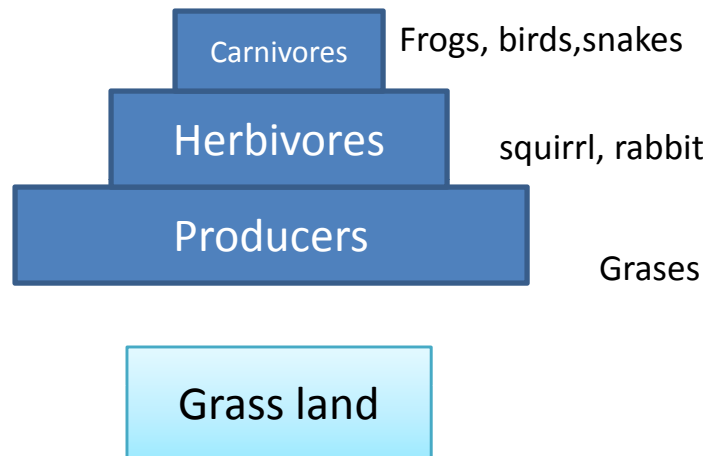
1. PYRAMIDS OF NUMBER



- Drawbacks
 1. The pyramid does not take in to account the size of the individuals. All considered to be equal
 2. The number of individual of a trophic level depends upon their biomass.

2. PYRAMIDS OF BIOMASS

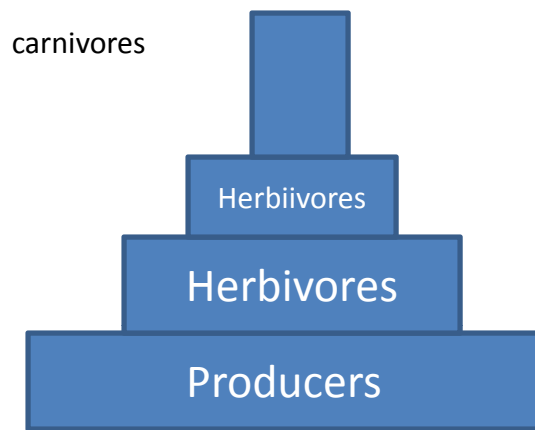
Top carnivores



- Drawbacks

1. Each trophic level indicates standing crops, which is different in different seasons. For eg, a deciduous tree has more biomass durring spring but less in autumn and winter
2. Life span of individual is not taken in to consideration, short life span organism may have high turn over
3. In aquatic ecosystem pyramid of biomass is often inverted in unfavourable periods(winter) and upright in favourable period (spring)
4. Biomass differs in its energy content in different organisms

3. PYRAMIDS OF ENERGY

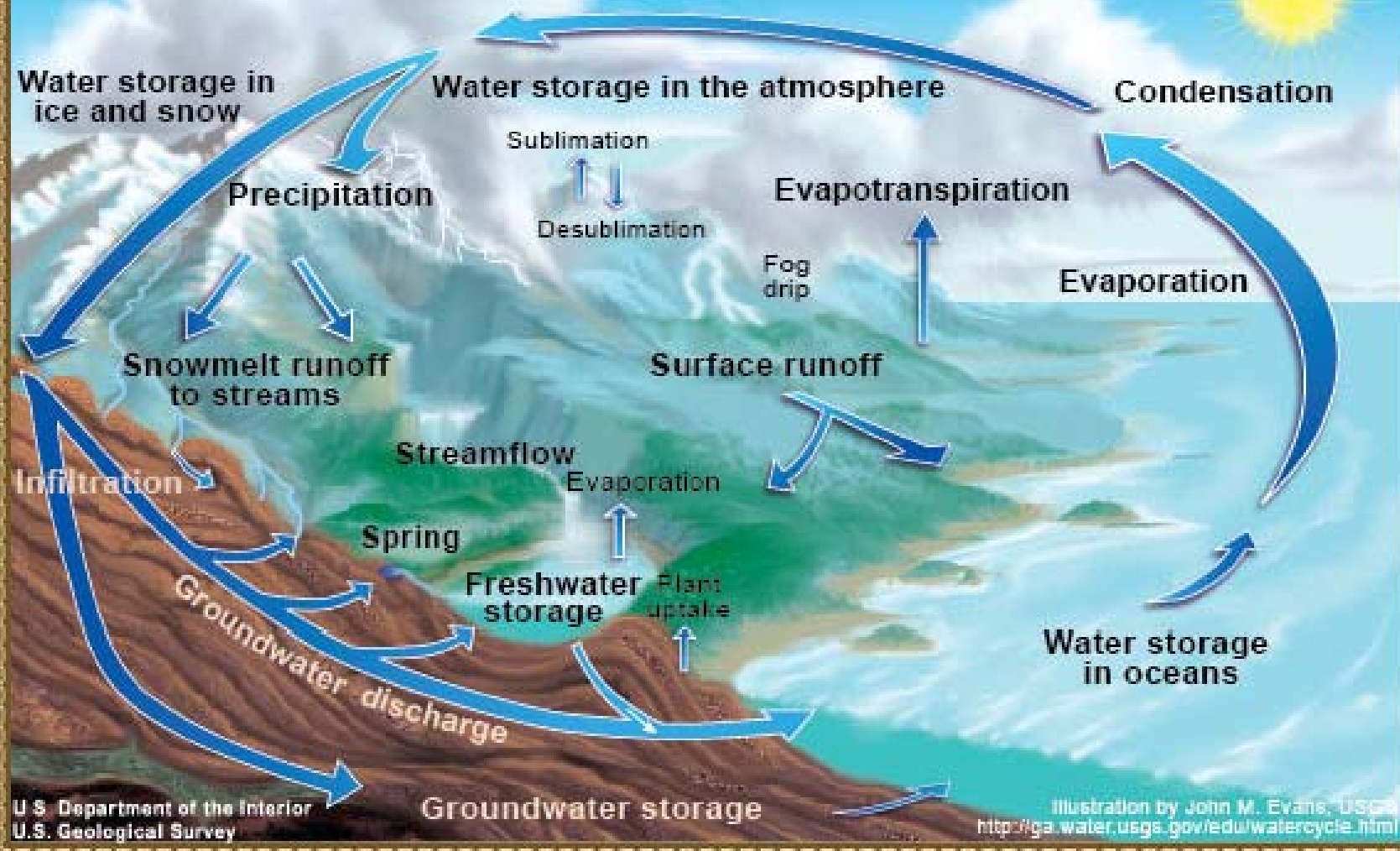


- Advantage
 1. Always upright
 2. Based on productivity
 3. Give idea of actual amount of energy received at a trophic level

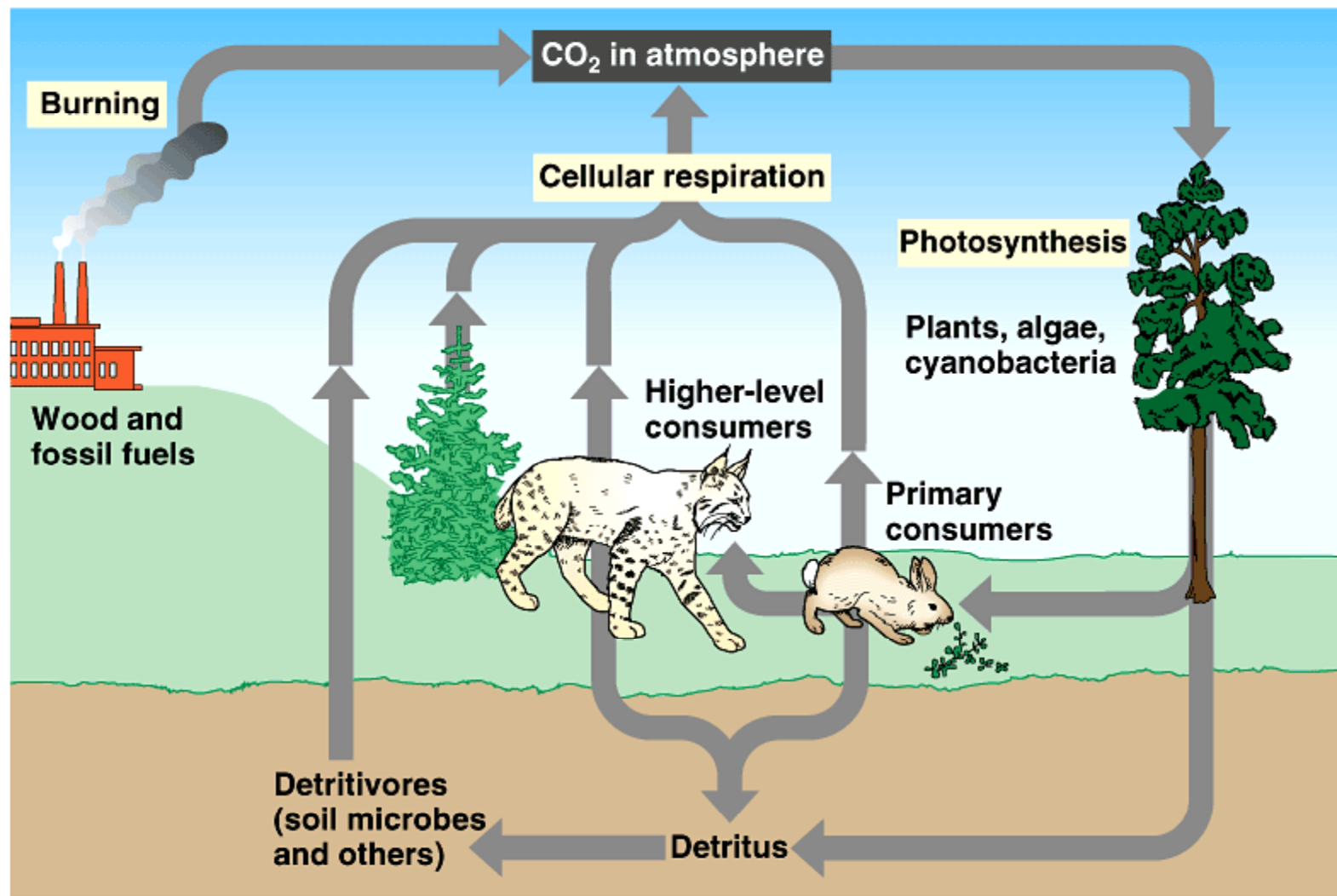
BIOGEOCHEMICAL CYCLES

- The cyclic exchange of nutrient materials between living organisms and their non living environment is called as biogeochemical cycles
- It includes
 1. Hydrologic or water cycle
 2. Gaseous cycle (include O₂ cycle, N₂ cycle)
 3. Sedimentary cycles(includes S, P, C)

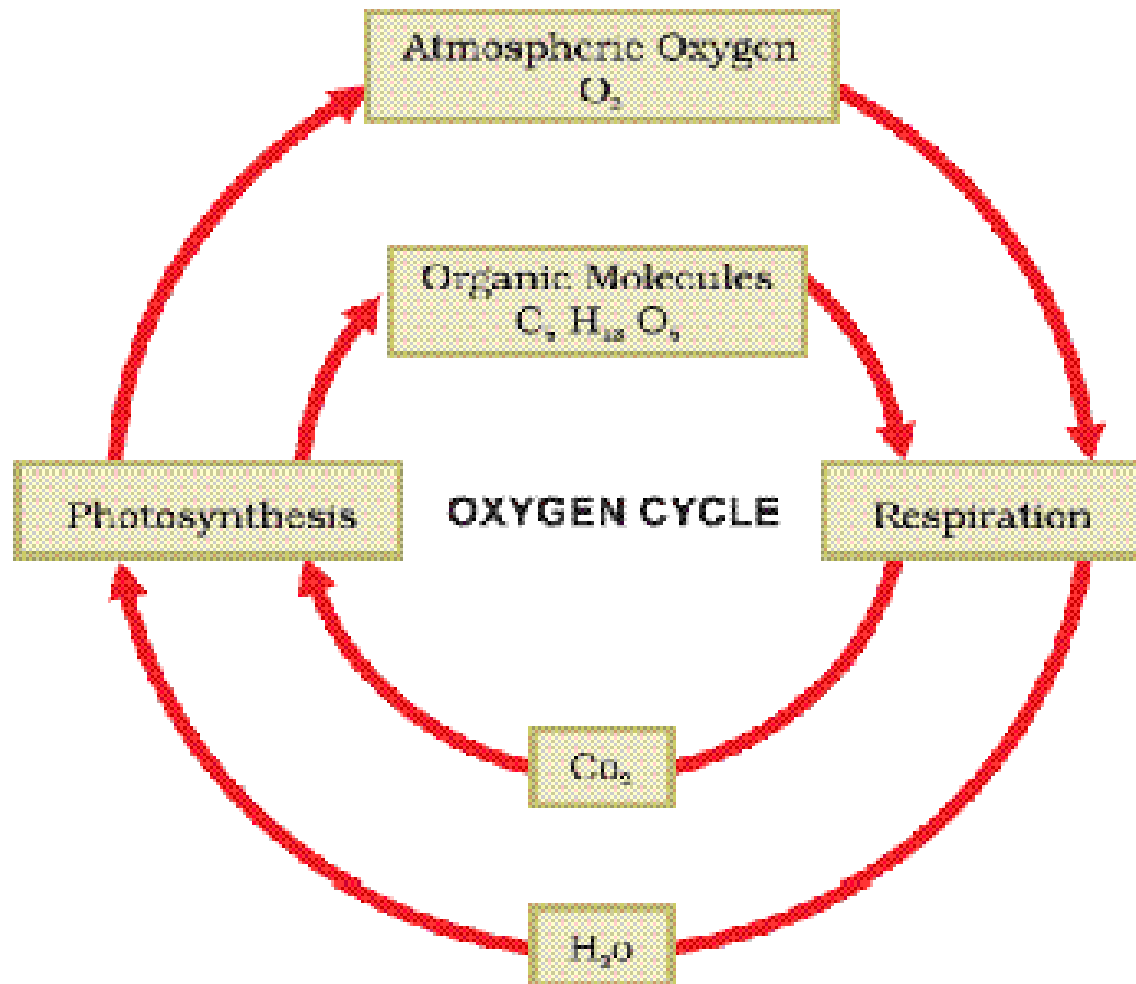
The Water Cycle



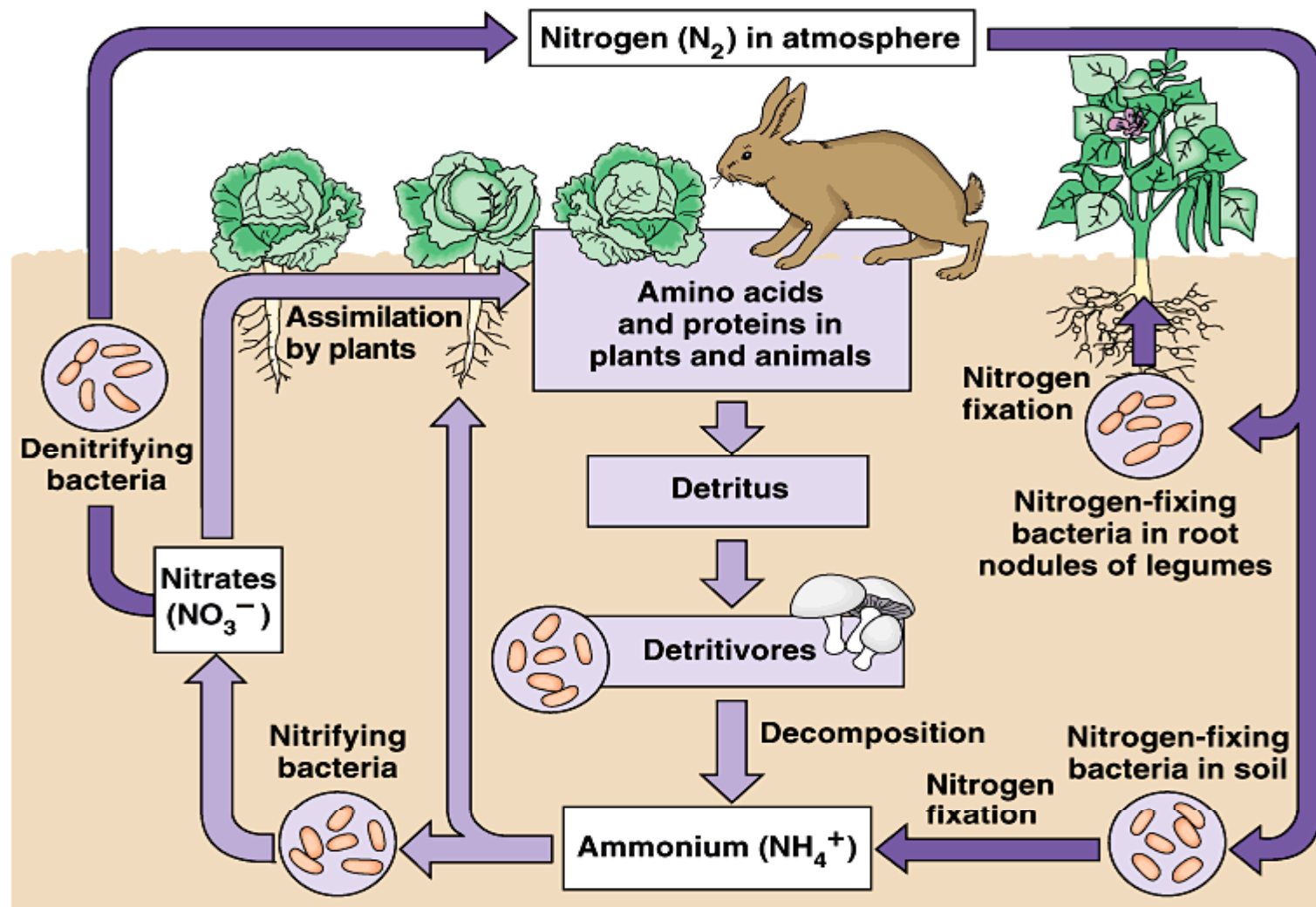
C cycle



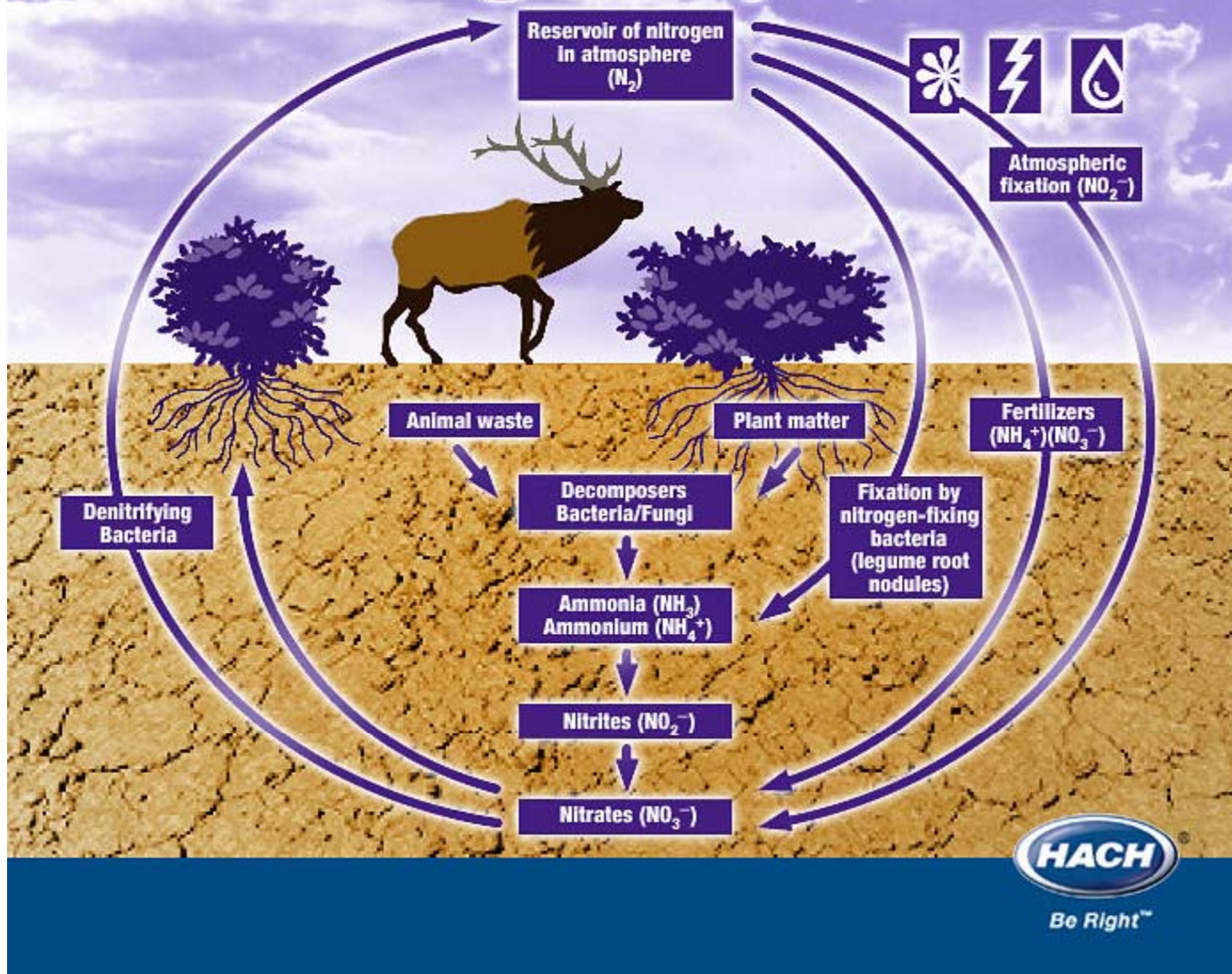
O₂ cycle



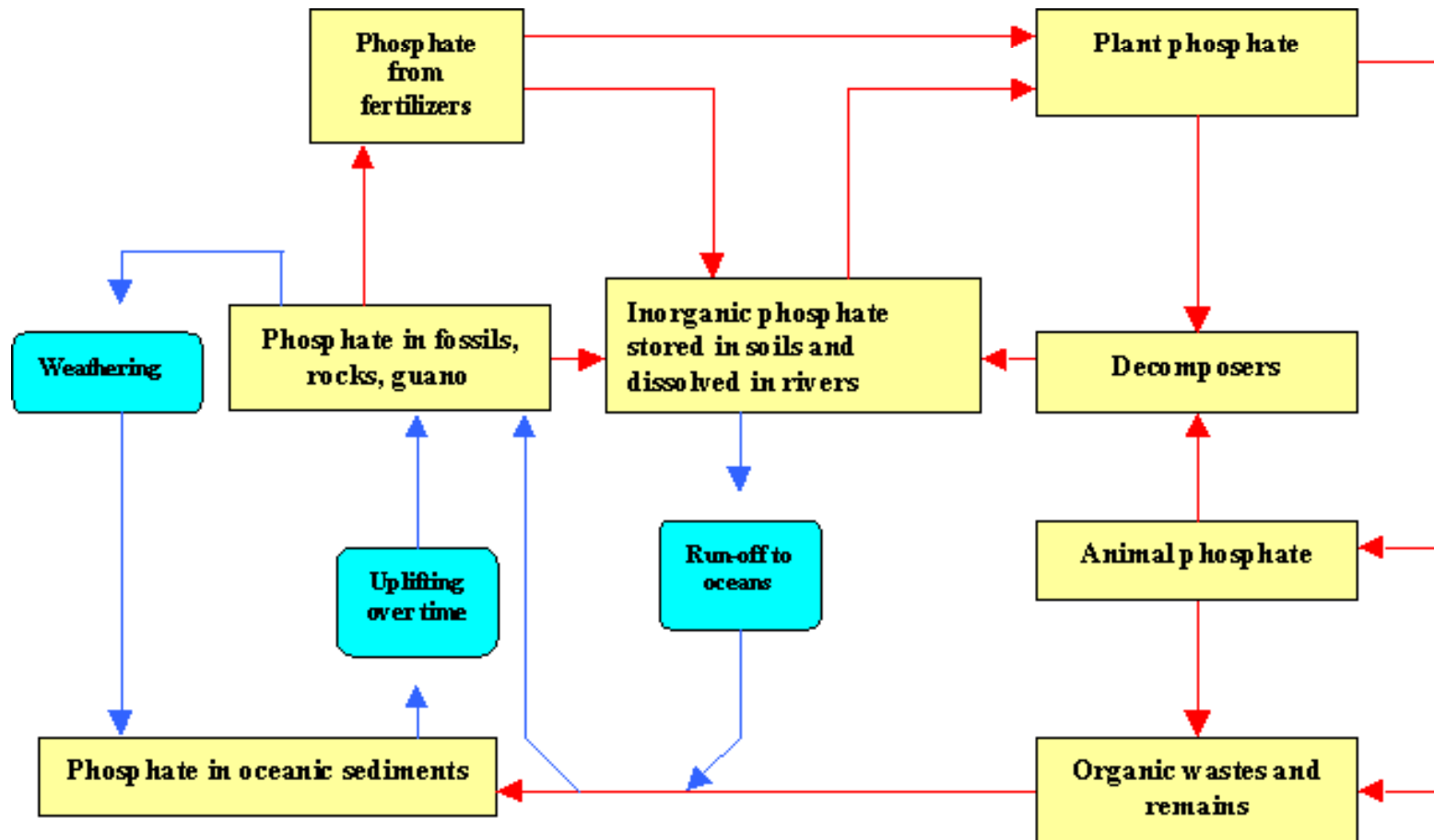
N₂ cycle



The Nitrogen Cycle

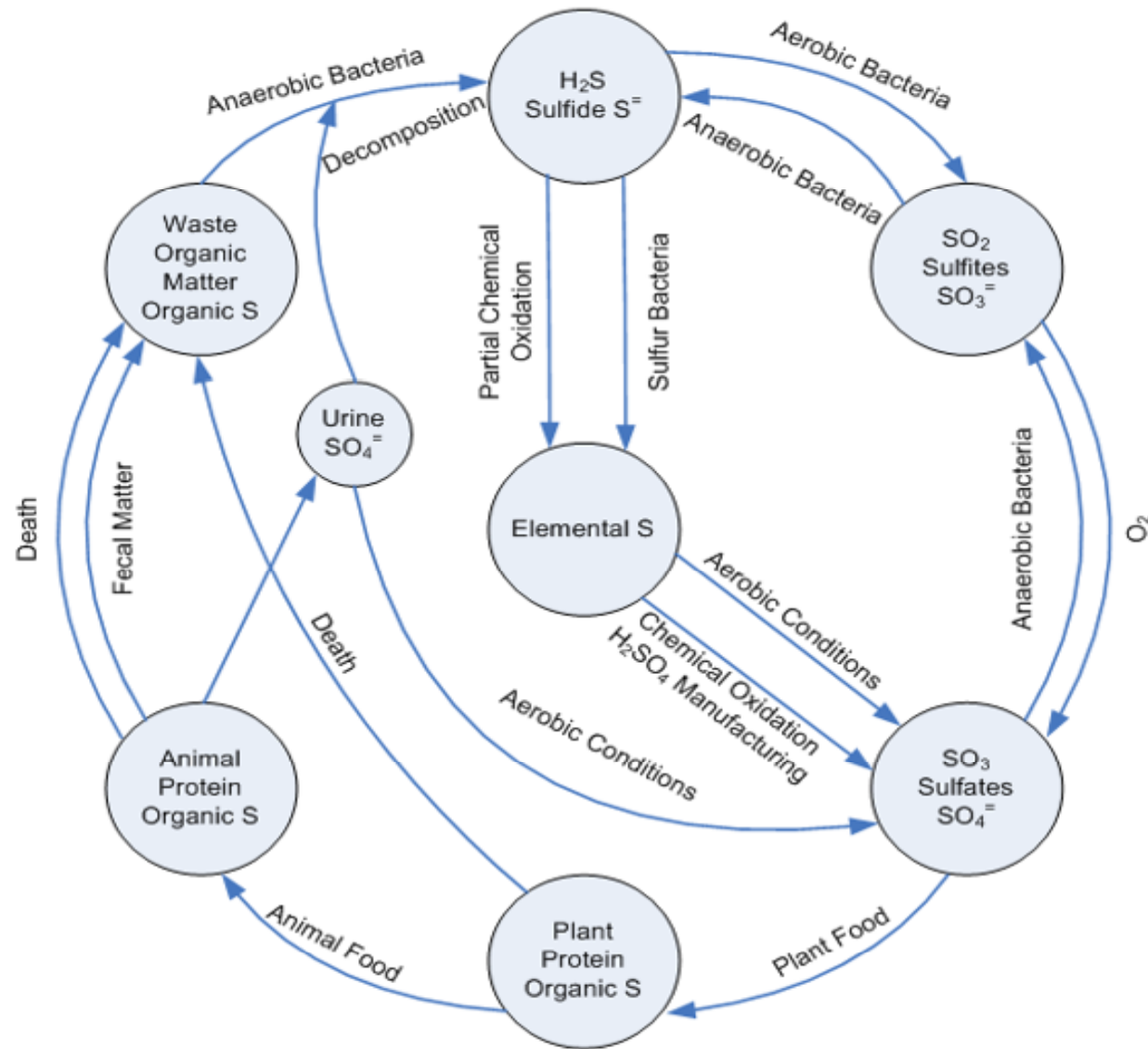


P cycle



The Sulfur Cycle

(U.S. EPA, 1985)



FOOD CHAIN

- In food chain each organism eats the smaller organisms and is eaten by larger one. All those organisms which are interlinked with each other through food together constitute the ecosystem
- There are mainly 3 trophic levels: Producers level, consumers level, decomposer level.
- Sunlight ----> Producers (grass)--→ primary consumers(rabbit)
---→ Secondary consumers(Fox)--→ Tertiary consumers(Wolf)---→ Quaternary consumers (tiger)----→ death--→ decomposers (bacteria, fungi etc)----→ inorganic substances-→grass
- 10% loss energy every stage
- Food chain depend on number of trophic level.
- Shorter food chain more available energy

TYPES OF FOOD CHAIN

1. Predator food chain or Grazing food chain : start from producers and end with higher consumer levels. In energy trophic level, the size of the organism increase while their number decreases.
 - E.g : Grass → Grasshopper → Toad → Snake

CONT...

2. Parasitic food chain: This type of food chain starts from big hosts and ends with parasitic organisms

- Cow → worm → Protozoa

3. Saprophytic food chain or detritus food chain: Start from dead organisms and end with decomposers such as bacteria

- Leaf litter → algae → crabs → Small fish → Large fish

SIGNIFICANCE OF FOOD CHAIN

- Food chain help to understand feeding relationship and interaction between organisms in any ecosystem
- It helps to understand the energy flow mechanisms and circulation of toxic substances in the ecosystem and the problem of biological magnification

BIOLOGICAL MAGNIFICATION

- Definition: It is tendency of pollutants to concentrated in successive tropic levels. Large concentration of pollutants could be detrimental if they are toxic.
- Biomagnifications occurs when organisms at the bottom of the food chain accumulate the toxic materials greater than that available in the environment around it.
- As DDT, heavy metal resemble inorganic nutrients these will taken up by plants along with the essential nutrients.
- If there is shortage of essential nutrients accumulation of these toxic material will be more and more
- This first step of biomagnifications is known as BIOACCUMULATION

CONT...

- The second type of biomagnification occurs when producers are eaten by consumers. The energy availability decreases from one trophic level to other. Thus successive trophic level consumes more and more toxic materials.
- This toxic material are not broken down in the body easily but they get quickly accumulated in the tissues.
- For e.g. toxic material like DDT soluble in fat easily.
- When consumers eat another consumers fat is digested and the pollutants move fats of another consumers.
- For water soluble toxic material, biomagnification cannot occur as they are dissolved in body fluids of the consumers and get excreted easily.

CONT...

- Man is omnivores and has all trophic level of food, he receives toxic substances large amount. Secondary and tertiary consumers at the top of the food chain also accumulate toxic materials in their body.
- Biomagnifaction of pollutant can be estimated with the help of biological concentration factor (BCF)

$$\text{BCF} = \frac{\text{Concentration of toxic material in organism}}{\text{Concentration of toxic material in environment}}$$

TROPHIC LEVEL

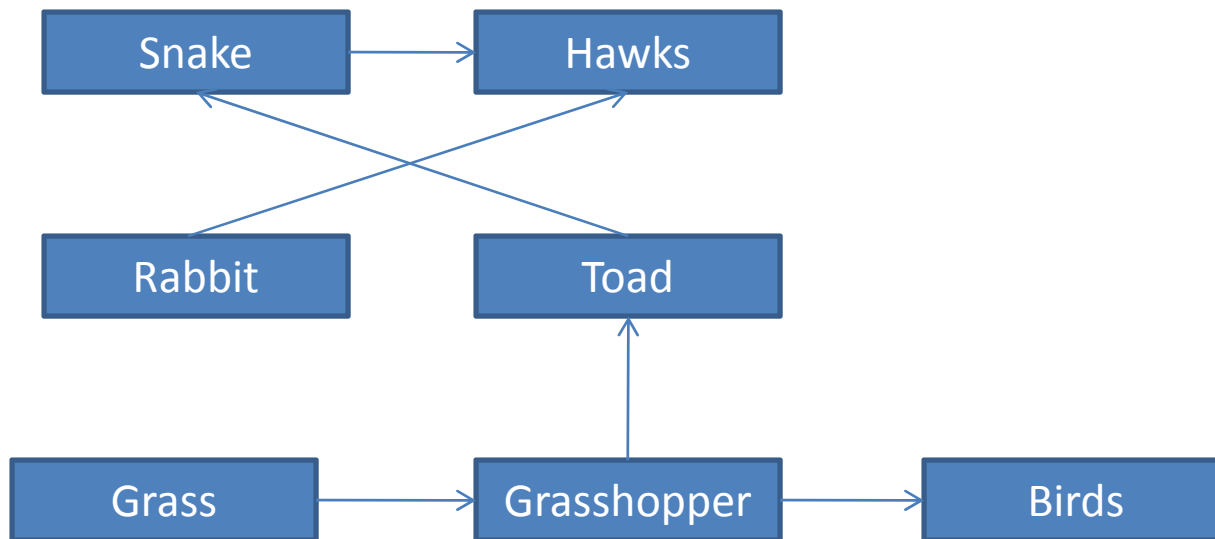
- All organisms feeding their food from plant. And plant make their food by own so plant is a first trophic level.
- Then plant is eaten by another primary consumers so it is called second trophic level.
- Like this successive trophic level is occur.
- e.g
 1. Wheat → Man
 2. Algae → Insects → Fish → Man

FOOD WEB

- DEFINATION: Various food chain are often interlinked at different trophic levels to form a complex interaction between different species from the point of view of food. This network like interaction is called as food web.
- It provides more than alternative of food, therefore increases their chances of survival.
- Charles Elton, a British ecologist, concluded that number of links a chain rarely exceeds five because in this process loss of energy occur.
- It is the energy transfer mechanisms determine number of links in food chain.

CONT...

- It maintain stability of ecosystem. It maintain the different patch way of ecosystem



FOREST ECOSYSTEM

- Forest ecosystem includes trees, shrubs, algae and variety of animals, plants and birds.
- Forest found moderate to high rain fall area

Function of forest ecosystem

- Enhance water resources both quantity and quality. Hydrological cycle depend on it
- It gives shelter to wild life
- It acts as sink for reducing CO₂ content in to atmosphere

COMPONENT OF FOREST ECOSYSTEM

Abiotic	Inorganic and organic substances, soil, atmosphere, climate
Biotic Producers components	Plants, species, shrubs, fruits, trees
Consumers	
Primary consumers	Flies, leaf hoppers, bugs, spider, large animals
Secondary consumers	Lions, tigers etc
Decomposers	Microorganisms, bacteria, virus, fungi

GRASS LAND ECOSYSTEM

- Includes :trees and shrubs
- Rainfall is average
- About $4.6 \times 10^7 \text{ km}^2$ of earth surface is covered with grass lands which occupy 32% of the plant cover of the world. Overgrazing of grass land converts into desertification

Three types of grass land

- Temperature grassland (25-100 cm of annual rainfall)
- Tropical grassland(150 cm of annual rainfall)
- Polar grassland (serve very cold, strong and fridge winds along with ice and snow)

COMPONENT OF GRASSLAND ECOSYSTEM

Abiotic	Soil and atmosphere like elements (C, H, O, N, P, S) which r supplied CO ₂ , H ₂ O, nitrates, phosphates and sulphates
Biotic Producers components	Grasses, shrubs and few forbs
Consumers	
Primary consumers	Cow buffalo, rabbit, mouse, incests
Secondary consumers	Snakes, lizard, birds, fox, jackal
Decomposers	Microorganisms, bacteria, virus, fungi

DESERT ECOSYSTEM

- Precipitation exceed less than 25 cm per year.
- Atmosphere is dry, poor insulator.
- Desert soil make cool quickly, night is cool

3 major types

- Tropical dessert like sahara and Namibia in Africa and Thar desert in Rajasthan. They have only few species. Wind blow sand dunes are very common
- Temperature dessert like Mojave in south California where temperature are very hot in summer but cool in winter.
- Cold desert like Gobi desert in China has cold winters and warm summers

COMPONENT OF DESERT ECOSYSTEM

Abiotic	Temperature in very high and rainfall is very low
Producers	Grasses, shrubs, trees
Consumers	Insects, reptiles, rodents, birds, camels etc
Decomposers	Poor vegetation, dead organic matter, fungi, bacteria etc

AQUATIC ECOSYSTEM

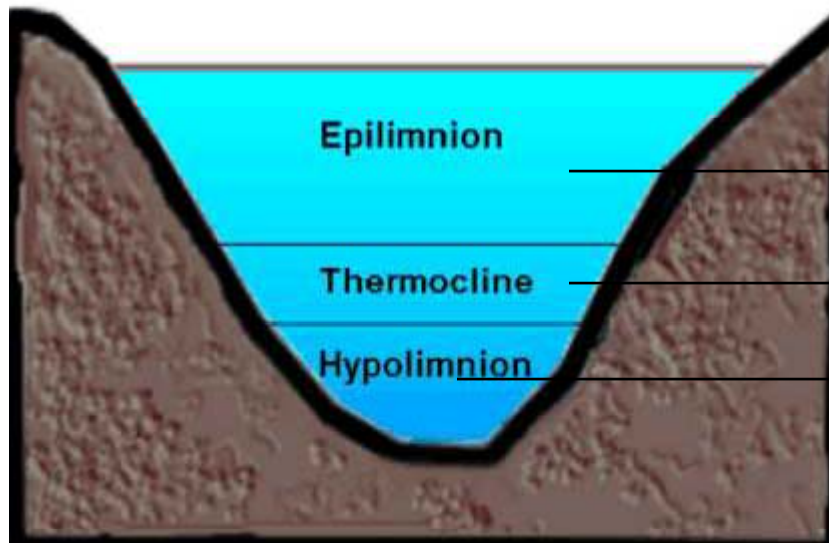
- Pond Ecosystem
- Lake Ecosystem
- Marine Ecosystem
- Estuarine Ecosystem

POND ECOSYSTEM

Abiotic	Temperature, light, water several inorganic and organic elements (C, H, O, N, P, S, Ca, Mg), carbohydrates, protein, lipids
Biotic Producers components	Green plants, algae, fungi
Consumers	
Primary consumers	Zooplankton (ciliates, flagellates, other crustacean like copepods and daphnia etc)
Secondary consumers	Carnivores: they feed herbivores like fish and insects
Tertiary consumers	Large fishes they feed smaller fishes
Decomposers	Microorganisms, bacteria, fungi

LAKE ECOSYSTEM

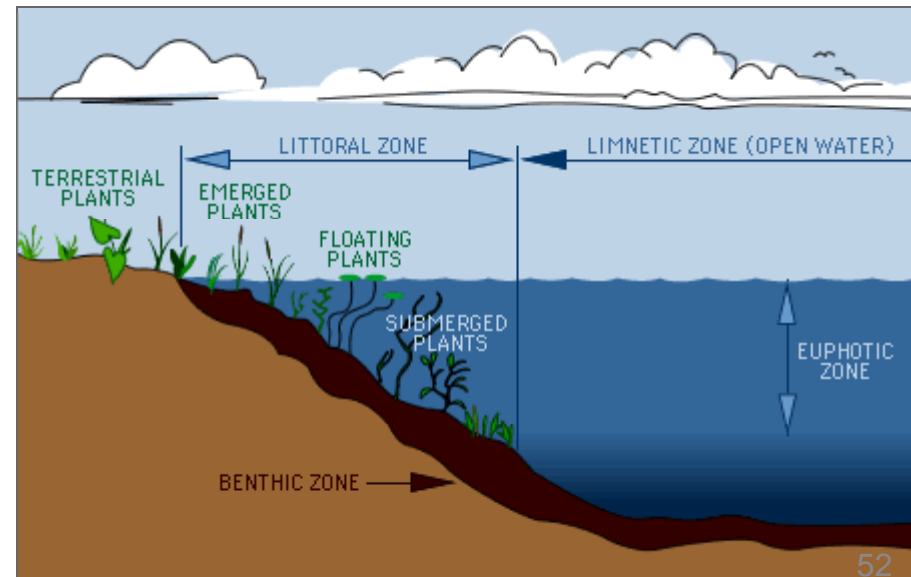
Summer Lake Stratification Zones



→ Warm, lighter, circulating surface area

→ Sharp drop in temperature

→ Cold, viscous, non circulating bottom layer



RIVER ECOSYSTEM

- Large stream flow down wards.

3 phase of river

- The mountain high land part has cold clear water rushing down as water falls with large amount of DO. The plants are attached to rocks and fishes are cold water, high O₂ requiring.
- In second phase gentle slopes, the water warmer and support a growth of plants and less O₂ requiring fishes
- In third phases, river water are very rich in biotic diversity. Moving down the hills, river shapes the lands.

MARINE ECOSYSTEM

- It includes ocean, estuaries and coral reef ecosystem

OCEAN ECOSYSTEM

- Covers 70-71 % earth surface.
- Survive 2,50,000 species. Serve food for human and other organisms, huge variety of sea products and drugs.
- Ocean provides us iron, phosphorus, magnesium, oil, natural gas, sand and gravel
- Major sinks of CO₂ play important role in biogeochemical cycles

OCEAN 2 MAJOR JONE

- COASTAL ZONE : warm, reach shallow water, high nutrients, sunlight, high primary productivity
- OPEN SEA: deeper part of ocean.

Further divide in 3 parts

- Euphotic zone
- Benthic zone
- Abyssal zone

OCEAN ECOSYSTEM

Abiotic	Salt, Ca, Mg, K salts water is buffered, dissolved nutrients
Biotic Producers components	Phytoplankton, marine plants
Consumers	
Primary consumers	Fish, molluscs, crustaceans
Secondary consumers	Carnivores fishes (herring, shad, Mackerels)
Tertiary consumers	Top consumers like fishes (Cod, Haddock)
Decomposers	Fungi, dead organic compound

TUTORIAL- 2

1. Write definition : (1) Ecology, (2) Ecosystem,(3) Producers or Autotrophs, (4) Consumers or Hetrotrophs, (5) Herbivores, (6) Decomposers or Reducers, (7) Ecological balance, (8) Ecological pyramid, (9) Biogeochemical cycles, (10) food chain, (11) food web, (12) biological magnification, (13) bioaccumulation, (14) trophic level.
2. What are the classification of ecology?
3. What are the types of ecosystem and explain structure of ecosystem?
4. Explain energy flow in an ecosystem.
5. Write a short note on Ecological pyramid
6. Write a short note on (1) hydrological cycle (2) Carbon cycle (3) O₂ cycle (4) N₂ cycle (5) Phosphorus cycle (6) sulfur cycle
7. Explain food chain and food web
8. Write a short note on (1) Forest Ecosystem (2)Pond Ecosystem (3)Marine Ecosystem

END